X-RAY ABSORPTION STUDIES OF THE cBN COMPOSITES WITH DIFFERENT BONDING PHASES

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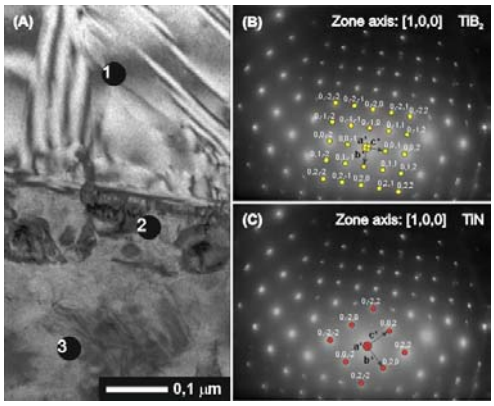
The cBN composites are widely used in various applications because of their excellent wear and corrosion resistance and their thermal and electronic properties. In order to obtain composition materials with optimal properties and using economic and safe for environment technology it is important to recognize chemical reactions occurring at boron nitride during formation of bonding phase. Titanium and their compounds are most commonly used as binders in sintering technology. We present the results of studies of cBN composites with addition of TiN and TiC ceramics to form a bonding phase. The wider class of additions is under investigation.

From thermodynamical calculations it follows that in the temperature range from 1000 to 1400^0C TiC and TiN react with cBN forming in the case of TiC two new phases (TiB_2 and $TiC_{0.8}N_{0.2}$) and only TiB_2 phase in the case TiN addition.

Composites were prepared by high pressure (9GPa) hot pressing (1750^oC) and the samples were subsequently heat treated at 1000 and 1400^oC for 1 hour in vacuum $3*10^{-3}$ Pa. Sinters of cBN-TiN/TiC before and after heat treatment were characterised using transmission electron microscopy and X-ray absorption technique.

RESULTS AND DISCUSSION

TEM studies of the microstructure in cBN sintered with TiN and heated up to 1400 ^{o}C



The microstructure of cBN sintered with TiN is compact. Analysis of the electron diffraction (Fig.1, B and C) allowed to conclude that the fine crystallites at the boundary show the TiB_2 phase (B) whereas the bigger grains inside the TiN phase (C). The cBN/TiC compact looks the same like cBN/TiN. But in some places the electron diffraction pattern indicates on the presence of the triple Ti(BC) compound.

Fig.1. Boundary between the two fine-crystalline area of cBN/TiN composite (A) and electron diffraction pattern from the point 2 (B) and 3 (C).

X-ray absorption study

X-ray absorption measurements were carried out at the Advanced Light Source of Lawrence Berkeley National Laboratory (beamline 6.3.2) and at the HASYLAB in Hamburg. (beamline A1). As an example are presented XANES at the Ti K-edge of cBN/TiN (Fig.2) and

Ti $L_{2,3}$-edge (Fig.3) from cBN - TiC/TiN.

Spectra show formation of the TiB_2 new phase after heating to 1300^0C, without heat treatment TiB_2 was not formed (Fig.2). The formed TiB_2 phase is not ideal, it can have defects and inclusions of other phases. The possibility of the foreign phases addition was check (upper curves) and conclusion can be drown that addition to the TiB_2 phase up to 30% of TiN phase does not improve the agreement between modelled and observed phase. In composites without heat treatment the inclusions of up to 20% TiC and 10% TiB_2 cannot be excluded.

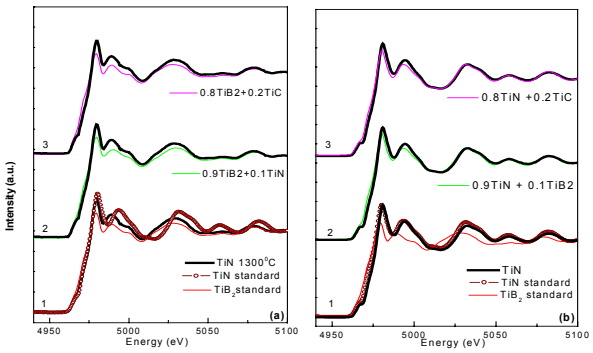


Fig. 2. The Ti K - edges of the cBN/TiN and reference samples heated up to 1300^0C (a) and cBN/TiN without heat treatment (b).

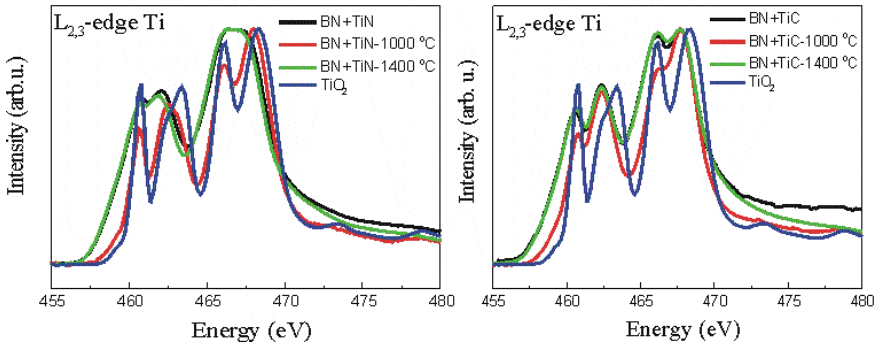


Fig.3. Ti $L_{2,3}$ x-ray absorption edge spectra of cBN/TiN and cBN/TiC composites before and after heat treatment and TiO_2 as reference.

The pick structure in Fig.3 shows formation of TiO_2 like phase in the cBN-TiN/TiC composites. It was proved that the temperature of 1000^0C was not high enough to avoid the oxidation of the composite grains, the heat treatment up to 1400^0C prevent the oxidation of grains.

Conclusion

X ray absorption measurements provide a clear spectroscopic signature of TiB_2 formation in the cBN-TiN/TiC composites. There was proved that the temperature of 1000^0C was not high enough to avoid the oxidation of the composite grains, therefore the heat treatment is necessary. The formed TiB_2 phase is not free from the defects but we do not observed foreign phase inclusion after heating.
From the analysis of the edge shape one can conclude on the chemical processes and optimise of the BN-TiC/TiN composites heat treatment procedure.

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